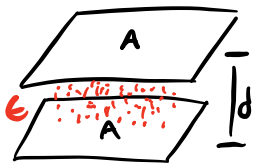
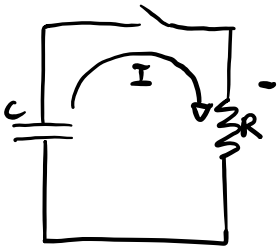
RC Circuits

$Q = CV \qquad C = \frac{\epsilon A}{d} \qquad \frac{dQ}{dt} = C\frac{dV}{dt}$

$I = C\frac{dV}{dt}$





$I_C = I_R$

$-C\frac{dV}{dt} = \frac{V}{R}$

$\frac{dV}{dt} = \frac{-V}{RC}$

$dV = \frac{-V}{RC}\,dt$

$\frac{dV}{V} = \frac{-1}{RC}\,dt$

$\ln(V)\Big|_{V_0}^{V_1} = \frac{-1}{RC}\,t$

$\ln(V_1 - V_0) = \frac{-t}{RC}$

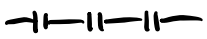
$\frac{\ln(V_1)}{\ln(V_0)} = \frac{-t}{RC}$

$\frac{V_1}{V_0} = e^{-t/RC}$

$V(t) = V_0 e^{-t/RC}$

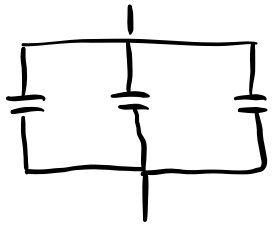
$V(t) = V_0 e^{-t/RC}$

Capacitors in Series

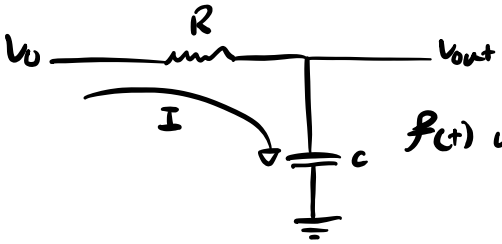


$C = \frac{C_1 C_2}{C_1 + C_2}$

Capacitors in Parallel



$C = C_1 + C_2 + C_3 + C_4$



$V_C(t)$ when V_C

$I = C\frac{dV}{dt} = \frac{V_{in} - V_{out}}{R}$

$RC\frac{dV}{dt} = V_0 - V_t$

$-RC\frac{dV}{dt} = V_t - V_0$

$u = V_t - V_0$

$du = dV$

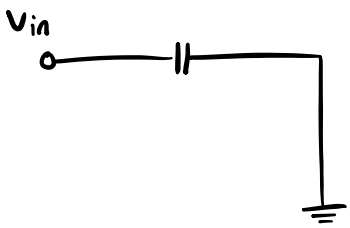
$-RC\frac{du}{dt} = u$

$-RC\,du = u\,dt$

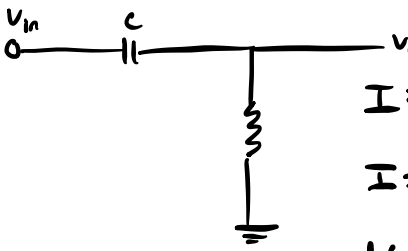
$\frac{du}{u} = \frac{-t}{RC}$

$V(t) = V_0(1 - e^{-t/RC})$

Differentiator



$I = C\frac{dV}{dt}$



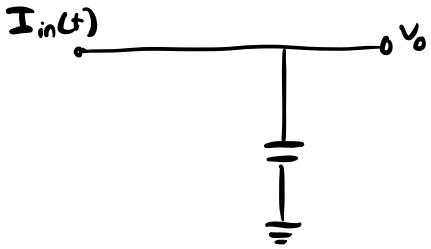
$I = C \cdot \frac{d(V_i - V_0)}{dt}$

$I = \frac{V_0}{R}$

$\frac{d(V_i - V_0)}{dt} = \frac{V_0}{RC}$

$\frac{dV_{in}}{dt} = \frac{V_0}{RC}$

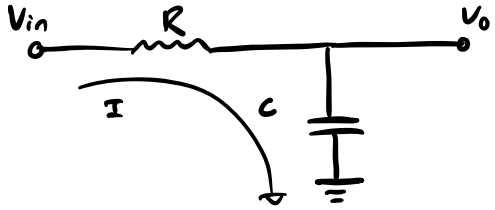
Integrator



$$I_{in}(t) = C\frac{dV}{dt}$$

$$\int I_{in}(t) = \int C\frac{dV}{dt}$$

$$\frac{1}{C}\int I_{in}(t) = V_o$$



$$\frac{V_i - V_o}{RC} = \frac{dV_o}{dt} \approx \frac{V_{in}}{RC} = \frac{dV_o}{dt}$$

$$V_o = 1/RC \int V_{in}(t)\,dt$$